

INNOVATIVE NUCLEAR ENERGY SYSTEMS AND RELATED R&D CHALLENGES

M. Salvatores

Argonne National Laboratory, USA, and CEA-DEN Cadarache, France

Innovative Reactor Systems, including both reactor concepts and the associated fuel cycles, are presently under study in several leading countries, in order to cope with requirements for improved economics, waste minimisation, safety and sustainability. The GENERATION-IV initiative is an outstanding, but definitely not the only one, example.

In the present paper we will focus mainly on the waste management and sustainability aspects.

These two fields provide the frame for the deployment of innovative technologies, with significant scientific challenges. The full paper will discuss and compare several promising scenarios, in terms of Plutonium and Minor Actinide management, and it will be shown the transition from a waste minimisation primary objective, to a full sustainability scenario for nuclear power development.

Evolutionary and revolutionary concepts both for reactors and fuel cycles are included in these scenarios: new types of fuels; fuel reprocessing, molten salts technologies, innovative PWR concepts, gas cooled reactors, Accelerator driven Systems.

A few selected examples will be examined in the paper, indicating major scientific challenges and experiments needed to be performed in order to validate the concepts.

In particular in the area of ADS, basic experiments already performed or being planned (like the TRADE experiment) will be discussed.

The ADS field of research is a good example of multidisciplinary R&D needs in several areas: new fuels, dedicated to waste transmutation; liquid metal technology; nuclear physics; accelerator technology; reactor physics and technology of multiplying sub-critical reactor cores.

In each area, new requirements have to be fulfilled: fuels with a high content of minor actinides and U-free; material compatibility with, e.g., lead alloys under irradiation of both neutrons and protons; accurate nuclear data in the energy range above 20 MeV; high power proton accelerators with unusually stringent requirement for reliability; the effective coupling of a particle accelerator, a spallation target and a power reactor core; the dynamic behaviour and the reactivity control of a sub-critical core in presence of an external source.

Indications will be given of R&D areas of relevance, including nuclear data, and of ongoing R&D programs and expected results. In particular, a consistent European program (EUROTRANS) to be launched in this domain will be described.